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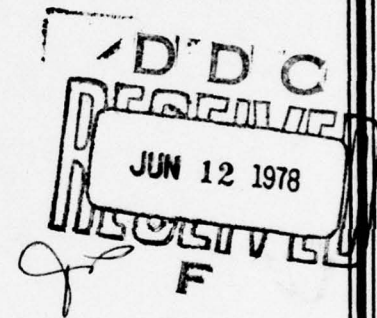


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ARMY ENERGY FLOW

Casimir A. Kukielka

4 November 1977



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FINAL REPORT

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Prepared by:

US Army Facilities Engineering Support Agency
Research and Technology Division
Fort Belvoir, Virginia 22060

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FESA-RT-2046	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) Army Energy Flow		5. TYPE OF REPORT & PERIOD COVERED (9) Final Report, 12
7. AUTHOR(s) (10) Casimir A. Kukielka		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS USA Facilities Engineering Support Agency Research and Technology Division Fort Belvoir, VA 22060		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (12) 27 p.		11. REPORT DATE 4 Nov 1977
16. DISTRIBUTION STATEMENT (of this Report) Distribution Unlimited; Approved for Public Release.		12. NUMBER OF PAGES
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) (14) USA FESA-RT-2046		13. SECURITY CLASS. (of this report) UNCLASSIFIED
18. SUPPLEMENTARY NOTES		14. DECLASSIFICATION/DOWNGRADING SCHEDULE
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Army Energy Consumption, Energy Utilization by Building Classification.		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The purpose of this study was to quantify energy consumption in the Army by fuel and by utilization. In performing this study several assumptions were made to supplement the existing meager data base.		

409 2.66

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EDITION OF 1 NOV 65 IS OBSOLETE

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	
REPORT NUMBER	FE2A-RT-2046
TITLE	
Army Energy Flow	
AUTHOR	
Castro, A. Kurioka	
PERFORMING ORGANIZATION NAME AND ADDRESS	
USAF Facilities Engineering Support Agency Research and Technology Division Fort Belvoir, VA 22060	
CONTROLLING OFFICE NAME AND ADDRESS	
11 NOVEMBER 1977	
12. SECURITY CLASSIFICATION	
UNCLASSIFIED	
13. DISTRIBUTION STATEMENT OF THIS REPORT	
Distribution unlimited; Approved for Public Release.	
14. SUBJECT TERMS	
Army Energy Consumption, Energy Utilization of Building Classification.	
15. DISTRIBUTION STATEMENT OF ABSTRACT	
UNCLASSIFIED	
16. ABSTRACT	
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ARMY ENERGY FLOW

1.0 INTRODUCTION

The purpose of this study was to quantify energy consumption in the Army by fuel and by utilization. In performing the study several assumptions were made. This results from the need to supplement the existing meager data base. A discussion of each assumption, the methodology employed, and areas where improvements can be made are discussed below.

2.0 ASSUMPTIONS

2.1. Assumption 1. Average consumption per square foot for each category taken from Botros (Ref 1) is assumed to be a constant throughout the Continental United States or an average value. Since these numbers were obtained from three installations in and around the greater Washington, DC area they lack the randomness with respect to entire US and thus cannot be said to represent a true average consumption for America. A larger sampling population would add credence to the average consumption figure for the US. However, the consumption figures used are considered a "best guess".

2.2. Assumption 2. Total building area by category was obtained from the Building Information Schedule (BIS). It was assumed that energy was consumed throughout the area. However, error is inherent in this assumption since buildings in each category have spaces not receiving utilities. This problem is most severe in the storage category.

2.3. Assumption 3. Using boiler data from the Facilities Engineering Handbook "76" as a guide it was assumed that process loads account for 12% of the Army energy consumption.

2.4. Assumption 4. The following conversion efficiencies have been assumed:

FUEL	%
Anthracite Coal	.65
Bituminous Coal	.65
Electricity	.95
Fuel Oil	.7
Natural Gas	.8
Purchased Steam & Hot Water	.8
Propane	.8

Since no standard efficiencies exist for Army facilities these efficiencies were chosen a priori and are considered realistic.

3.0 METHOD OF ANALYSIS

1. Consumption data by fuel was gathered from the DEIS reports.
2. Reports on total area by category were requested from Real Property. Table I shows the breakout by category number.
3. Using the assumed efficiencies utilized energy and the wasted energy were calculated.
4. Using consumption averages from Botros' study the number of BTU's consumed by category was obtained.

5. Summing the results of step four, the total consumption was obtained. With this number as a base the percent consumption was calculated for each category.

6. These percentages were then multiplied by total energy consumption obtained in Step 1 (DEIS) to yield energy consumption by each category.

4.0 RESULTS

1. Table II, Figure 1, Energy Flow Chart by Fuel.

2. Inventory of Army Buildings by Category.

a. Army Total, Table III.

b. By major commands, Table IV - VII.

3. Army energy consumption by category and major command, Table VIII,

Figure 2.

4. Input energy to Army boilers & heating plants, Figure 3.

5.0 ALTERNATIVE APPROACH

The major problems of this analysis were discussed with each assumption. These problems are briefly outlined below:

1. Assumption #1

a. Limited data base for calculating Army US consumption per unit area by category.

b. Data non-random

2. Assumption #2

Areas not receiving utilities are included in category totals.

3. Assumption #3

Assumed process load of 12% and conversion efficiencies lack a firm quantitative base.

Assumption one can be improved by applying statistical techniques. A random sample by similar climatic region of each category could be obtained since all the required information is cataloged on a computer file. The sample population size can be determined by assuming a normal distribution of facilities as a function of consumption per square foot. This assumption is justified under the central limit theorem.

Assumption two can be improved by querying the utility service column of the BIS and excluding buildings not having utility services. This will eliminate buildings not consuming energy, however, the BIS does not distinguish between gross area and that which is served by utilities. Thus areas not receiving utilities cannot be totally excluded when using the BIS.

Assumption 3 & 4 will require extensive metering since no field data exists at the present time.

Due to the above considerations the results are of questionable validity for anything other than gross calculation or rough estimates.

BREAKOUT OF BUILDINGS BY CATEGORY NUMBER

<u>Building Type</u>	<u>Category Number</u>
Training	170
Maintenance	200's
Storage	421, 424, 431, 432, 441, 442
Hospitals & Medical	500's
Administrative & Offices	600's
Family Housing	711 through 714
Troop Housing	721 through 725
Community Services	730 through 749
Other	111 through 160, 300, 760, All 800's

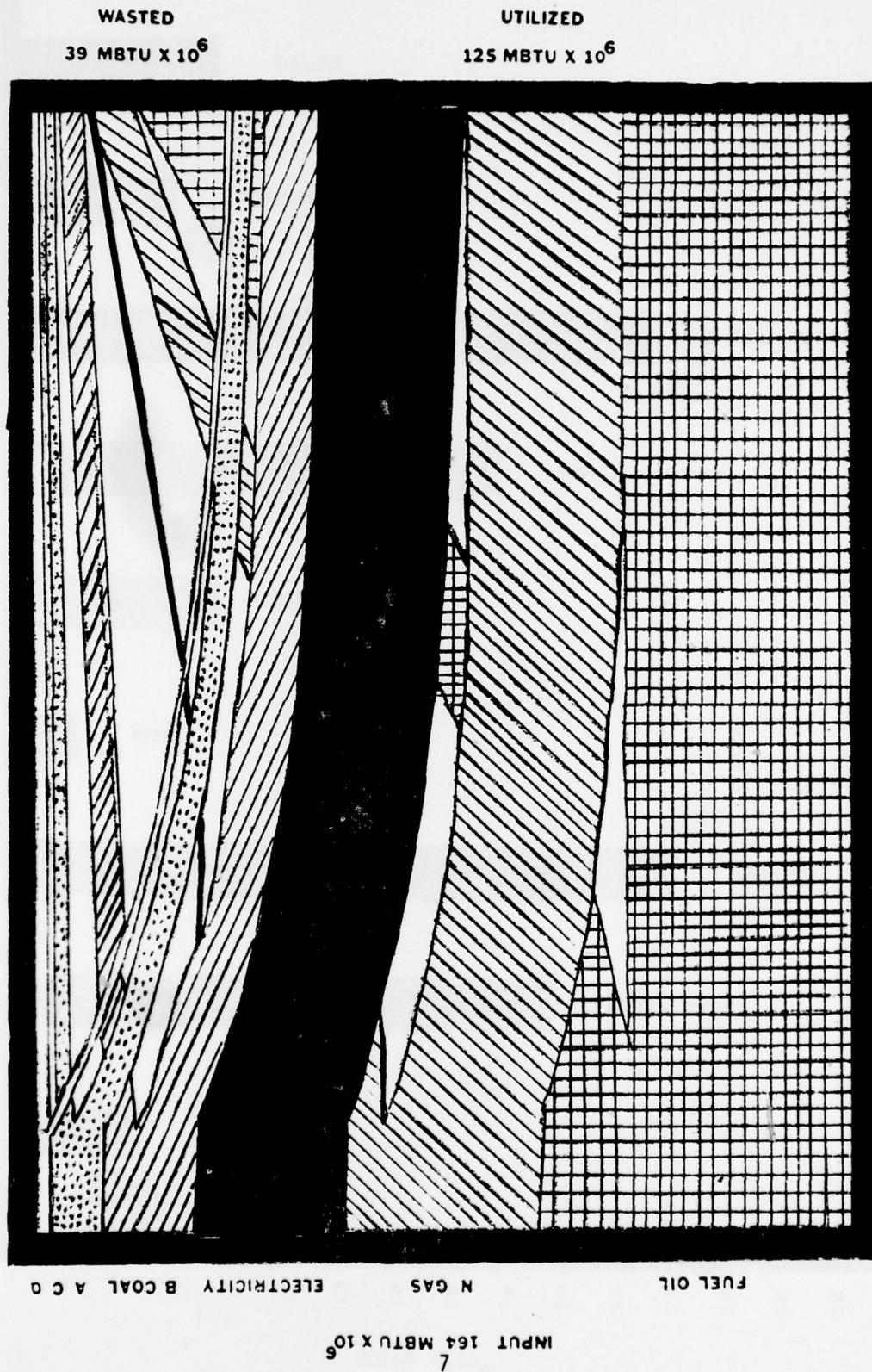
TABLE I

ENERGY UTILIZATION BY SOURCE FUEL

<u>Source Fuel</u>	<u>Used MBTU's</u>	<u>Rejected MBTU's</u>
Anthracite Coal	6,172,000	3,323,000
Bituminous Coal	13,469,000	7,253,000
Electricity	26,258,000	1,382,000
Fuel Oil	43,547,000	18,663,000
Natural Gas	32,770,000	8,192,000
Propane	1,667,000	417,000
Steam & Hot Water	<u>596,000</u>	<u>149,000</u>
	124,479,000	39,379,000

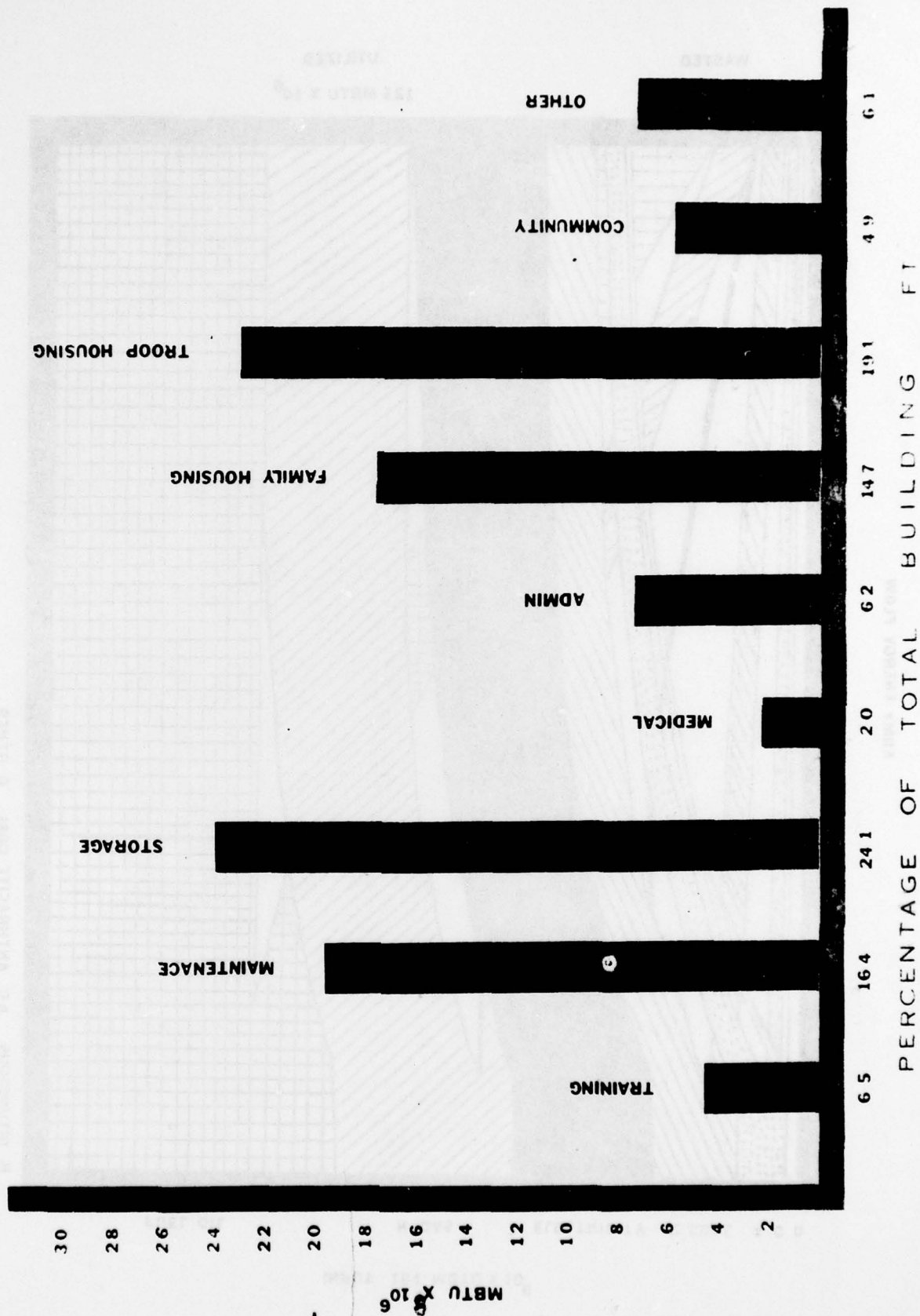
TABLE II

ARMY ENERGY FLOW



B. BITUMINOUS A.C. ANTHRACITE COAL O. OTHER.

Figure 1



INVENTORY OF ARMY BUILDINGS

GRAND TOTAL CONUS	NO. BLDGS.	% OF TOTAL	SQUARE FEET X 10 ³	% FT ² OF TOTAL	AVERAGE SIZE (FT ²)
Training	4,540	3.09	37,595	5.02	8,280
Maintenance	14,776	10.07	94,324	12.59	6,380
Storage	33,646	22.93	183,169	24.45	5,440
Hospitals & Medical	1,672	1.14	18,650	2.49	11,150
Admin & Ofcs.	4,979	3.39	50,899	6.79	10,220
Family Housing	42,040	28.65	136,354	18.20	3,240
Troop Housing	20,660	14.08	138,987	18.55	6,730
Community Services	9,176	6.25	47,473	6.34	5,170
Other	15,239	10.38	41,631	5.56	2,730
	146,728	100%	749,082	100%	5,105

3368 Building 300 sq ft of greater totaling 36,639,466 sq ft.

21,814 Buildings between 5 & 30 K sq ft totaling 26,284,591.

TABLE III

INVENTORY OF DARCOM BUILDINGS

GRAND TOTAL CONUS	NO. BLDGS.	% OF TOTAL	SQUARE FEET X 10 ³	% FT ² OF TOTAL	AVERAGE SIZE (FT ²)
Training	305	.7	3,000	.4	9,836
Maintenance	8,853	19.5	57,005	7.6	6,439
Storage	22,456	99.5	100,444	13.4	4,473
Hospitals & Medical	122	.3	1,023	.1	8,385
Admin & Ofcs.	1,254	2.8	13,694	1.8	10,920
Family Housing	3,987	8.8	10,335	1.4	2,592
Troop Housing	437	1.8	4,557	.6	10,428
Community Services	2,235	4.8	5,635	.7	2,521
Other	5,759	12.6	17,831	2.4	3,096
	45,408	100.	213,524	28.5	

TABLE IV

INVENTORY OF FORSCOM BUILDINGS

GRAND TOTAL CONUS	NO. BLDGS.	% of TOTAL NUMBER	SQUARE FEET Y10 ³	% ft ² of TOTAL	AVERAGE SIZE (ft ²)
Training	1814	3.4	15,334	5.9	8453
Maintenance	3240	6.0	20,051	7.7	6188
Storage	5619	10.4	29,030	11.2	5166
Hospitals & Medical	885	1.6	8,833	3.4	9981
Admin & Offices	1763	3.3	19,788	5.7	8388
Family Housing	21445	39.8	71,752	27.6	3346
Troop Housing	10571	19.6	68,519	26.4	6482
Community Services	3638	6.7	21,196	8.1	5810
Other	4972	9.2	10,210	3.9	2054
	53,947		259,663	.347	

TABLE V

INVENTORY OF TRADOC BUILDINGS

GRAND TOTAL CONUS	NO. BLDGS.	% OF TOTAL NUMBER	SQUARE FEET X 10 ³	% FT ² OF TOTAL	AVERAGE SIZE (FT ²)
Training	2,053	5.7	16,628	9.5	8,099
Maintenance	2,082	5.8	11,371	6.5	5,462
Storage	3,872	10.7	12,415	7.1	3,206
Hospitals & Medical	536	1.5	6,385	3.6	11,912
Admin & Ofcs.	1,305	3.6	9,386	5.3	7,789
Family Housing	13,595	37.7	44,529	25.3	3,275
Troop Housing	7,296	20.2	53,743	30.6	7,366
Community Services	2,447	6.8	15,054	8.6	6,152
Other	2,874	8.0	6,283	3.6	2,186
	36,060		175,794		

INVENTORY OF OTHER BUILDINGS

GRAND TOTAL CONUS	NO. BLDGS.	% OF TOTAL NUMBER	SQUARE FEET X 10 ³	% FT ² OF TOTAL	AVERAGE SIZE (FT ²)
Training	368	3.3	2,633	2.6	7,155
Maintenance	601	5.3	5,897	5.9	9,812
-Storage	1,699	15.0	41,280	41.2	24,297
Hospitals & Medical	129	1.1	2,409	2.4	18,674
Admin & Ofcs.	657	5.8	13,031	13.0	19,834
Family Housing	3,013	26.6	9,738	9.7	3,232
Troop Housing	2,356	20.8	12,168	12.2	5,165
Community Services	856	7.6	5,638	5.6	6,568
Other	1,634	14.4	7,307	7.3	4,472
	11,313	7.7	100,101	100.	

TABLE VII

ARMY ENERGY CONSUMPTION BY BUILDING CATEGORY IN MBTU'S

(Does Not Include Process Loads)

	TOTAL ARMY	DARCOM	FORSCOM	TRADOC	OTHER
Training	7,791,680	615,633	3,196,749	3,453,133	548,931
Maintenance	19,659,008	12,125,565	3,440,912	2,614,444	1,474,052
Storage	28,889,152	15,841,887	4,597,915	1,958,076	6,506,847
Hospitals & Medical	2,397,440	131,506	1,137,810	820,786	310,311
Admin & Ofcs.	7,432,004	1,999,526	2,155,539	1,370,494	1,899,434
Family Housing	17,621,184	1,338,188	9,260,873	5,754,534	1,256,861
Troop Housing	22,895,552	750,682	11,303,311	8,853,006	2,007,307
Community Services	5,873,728	697,206	2,642,891	1,862,598	704,654
Other	7,312,192	3,131,889	1,807,169	1,103,564	1,293,339
	119,872,000	36,632,082	43,352,995	27,790,635	16,666,597

TABLE VIII

INPUT ENERGY TO ARMY BOILERS AND HEATING PLANTS.

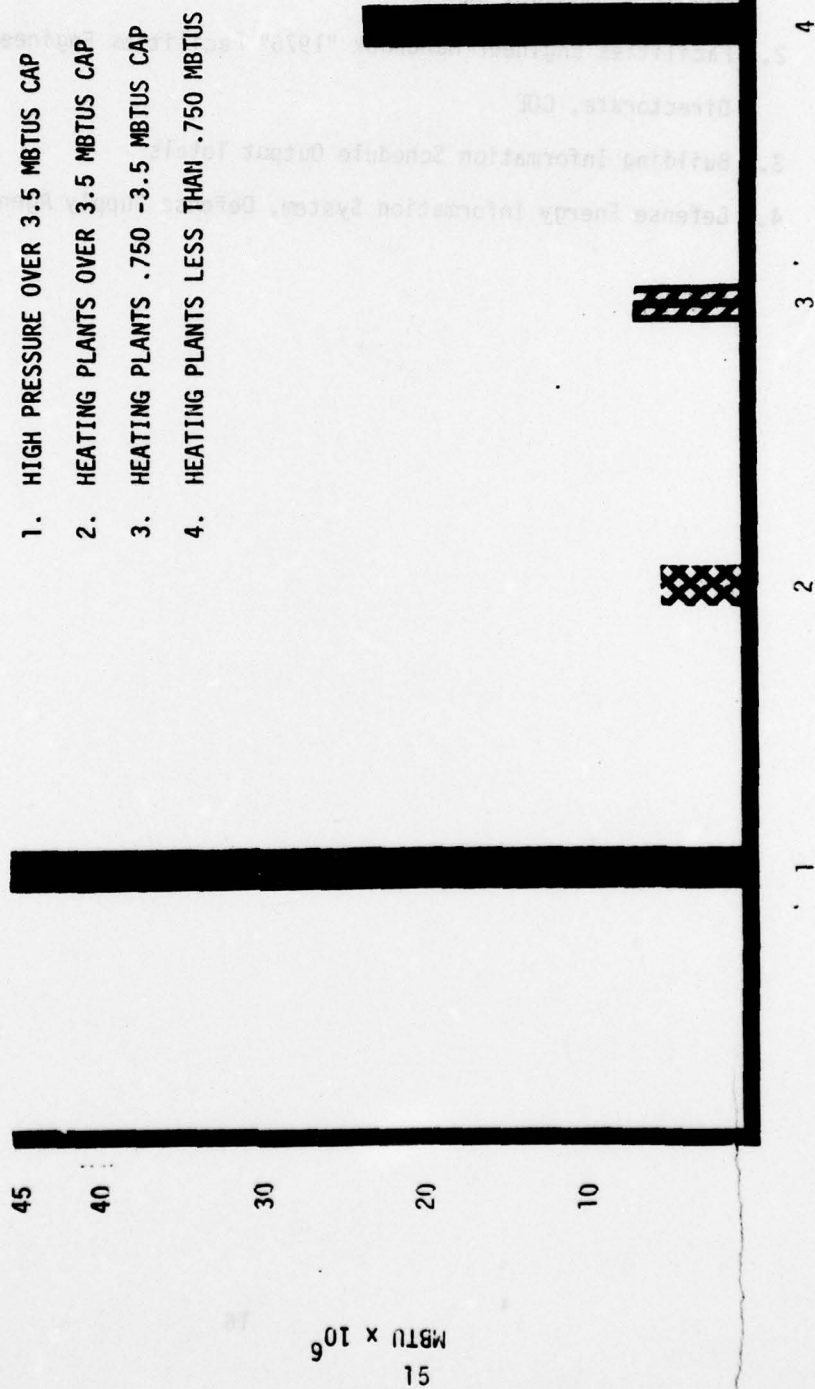


Figure 3

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Directorate, COE
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